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(54) Improved printability paperboards.

(57) Paperboard of the kind used for making business cards, invitation cards, menu cards, report covers and the like is surface enhanced by the application of a low coatweight (typically 1 to 5 g m $^{-2}$) coating of (a) a pigment having an oil absorbency of at least about 80 g/ 100 g pigment, and (b) a binder. The pigment is preferably an aluminosilicate, a symthetic amorphous silica, a calciumed kaolin, or an acid-washed montmorillonite clay, and the binder is preferably a styrene-butadiene latex. The coating reduces set-off and enhances print density after offset printing whilst not substantially affecting the aesthetic character of the product compared with conventional uncoated paperboard.

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This invention relates to paperboards of the kind used for making business cards, invitation cards, menu cards, covers for reports and such like. Such paperboards are often referred to as Ivory Boards or Bristols. They are typically woodfree products having a grammage of 200 to 400 g m^{-2} or more, a thickness of 200 to 380 μm or more, and a calendered smooth surface finish (by a "woodfree product" is meant a product which consists essentially of chemical rather than mechanical pulp). 200 g m^{-2} and 250 μm are not to be taken as absolute minimum values for grammage and thickness respectively of paperboards of the kind referred to - the expression "paperboard" as used in this specification extends at least to products of 180 g m^{-2} grammage and 150 μm thickness.

Products of the kind just referred to normally have to be printed, and it is important therefore that the paperboard stock from which they are cut should have good printability characteristics, in particular low set-off and ink-rub. "Set-off" refers to transfer of still-wet ink from a printed card to the underside of the next card above it in a stack. "Ink rub" refers to the tendency of still-wet ink printed on the card to smudge when in sliding or rubbing contact with another surface, for example the underside of the next card above it in a stack.

Conventionally, paperboard of the above-mentioned kind is surface sized, typically with starch, but is otherwise uncoated and is calendered to a smooth surface finish. This smooth surface finish increases the tendency for set-off and ink rub to occur, since there are no pronounced "hill and valley" surface features. "Hills" on adjacent sheets tend to prevent ink in the "valleys" from contacting and transferring to an adjacent sheet and also serve to shield ink in the "valleys" from rubbing forces.

The occurrence of set-off and ink rub has in the past often been thought to be in part a consequence of the smooth compacted surface produced by the calendering operation - this surface was thought to "hold out" the applied ink, i.e. to retard its absorption, and thus to make it more susceptible to set-off or smudging.

We have found however that conventional uncoated paperboard is in fact relatively absorbent, despite its smooth compacted surface, and that this is a major factor in the occurrence of set-off and ink rub.

Ink setting on paper products generally is usually the result of two complementary processes : absorption of the non-drying fraction of the ink, i.e. thin oil(s), often containing anti-oxidants to give storage stability, and oxidative polymerisation of the heavier resin based or "varnish" fraction left on the surface of the paper (this fraction also contains the ink pigments). In effect, a selective filtration of the ink occurs. Pigment-coated papers or paperboards are particularly suited to high quality printing because the non-drying fraction of the ink is readily absorbed through the porous coating by capillary action, whereas the ink pigment and heavier varnish are left on the surface where they are of most effect. The varnish sets readily in the presence of oxygen and the absence of the thin oil component of the ink.

By contrast, uncoated paperboard is not especially effective in selectively filtering the ink, because its relatively absorbent nature allows the heavier varnish component to be absorbed together with the thin oils. As a result ink setting takes longer, and the tendency for set-off and ink rub is increased, particularly if slow-setting inks are used. Further drawbacks are that the adhesion of the pigment to the paper is reduced and the ink pigment tends to get carried into the paper rather than remaining on the surface, with the result that the final print has less brightness, sharpness and general visual appeal. The last mentioned properties are very important where the presentational impact of the final product is important, as is the case with business cards, invitations, menu cards, report covers and the like.

It is an object of the invention to eliminate or reduce the above-described drawbacks of uncoated paperboards and to produce a product which has improved printability characteristics, particularly offset litho printability characteristics, whilst retaining the general "feel", appearance and properties associated with uncoated paperboards of the kind in question.

We have now found that this object can be achieved by surface enhancement of the paperboard by application of a low coatweight coating of a pigment having high oil absorbency characteristics, together with a conventional paper coating binder. By "high oil absorbency" is meant a pigment with an oil absorbency of at least about 80 g/100 g pigment (as measured by ASTM Standard No. D2414). This compares with oil absorbency values of 40 g to 75 g/100 g pigment which are typical of kaolin, calcium carbonate or other coating pigments as conventionally used in coated papers and paperboards. By low coatweight is meant a coating which only partially covers, or barely covers, the surface of the paperboard and is such that the product substantially retains the appearance and properties present in a comparable uncoated board. Typically, such a low coatweight coating has a coatweight in the range 1 to 5 g m^{-2}. By contrast, the much heavier coatweight coatings present in conventional coated paperboards typically have a coatweight of at least 7 g m^{-2}.

Accordingly, the present invention provides in broad terms an improved printability paperboard of the kind used for making business cards, invitation cards, menu cards, report covers and the like, characterized in that the paperboard carries a low coatweight coating of a high oil absorbency pigment and a binder.

The high oil absorbency pigment may be, for example, an aluminosilicate, a synthetic amorphous silica, a calcined kaolin, or an acid-washed montmorillonite clay of the kind commonly used as a colour developer in

pressure-sensitive copying paper and as disclosed in British Patent No. 1213835.

Examples of suitable aluminosilicates are the products sold under the trade marks "Zeocopy" and "Zeolex 123" by Zeofinn Oy, of Hamina, Finland (subsidiary of J.M. Huber Corporation, U.S.A.). The "Zeocopy" product was developed for use as a colour developer in pressure-sensitive copying paper and has an oil absorbency of c. 93g/100g pigment (100 ml/100 g pigment), a mean particle size of about 3.5 μm, as determined by means of a Coulter Counter, and a B.E.T. surface area of c. 230 $m^2 g^{-1}$ (manufacturer's data in each case). The "Zeolex 123" product was developed as a general filler and coating pigment for paper and has an oil absorbency of c. 84g/100g pigment (90 ml/100 g pigment), a mean particle size of about 3.0 μm, as determined by means of a Coulter Counter, and a B.E.T. surface area of 80 $m^2 g^{-1}$ (manufacturer's data in each case).

Examples of suitable silicas are products sold under the trade mark "Gasil" by Crosfield Group, of Warrington, England (subsidiary of Unilever, U.K.), particularly "Gasil 200 DF". This product has an oil absorbency of c. 80 g/100 g pigment, a mean particle size of 5 μm, as determined by means of a Coulter Counter, and a B.E.T. surface area of 750 $m^2 g^{-1}$ (manufacturer's data in each case).

An example of a suitable calcined kaolin is the product sold under the trade mark "Ansilex 93" by Engelhard Corporation, U.S.A. This product has an oil absorbency of c. 90 g/100 g pigment, a mean particle size of about 0.8 μm, and a B.E.T. surface area of 16 $m^2 g^{-1}$ (manufacturer's data in each case).

An example of a suitable acid-washed montmorillonite clay is the product sold under the trade mark "Silton" by Mizusawa Industrial Chemicals Ltd., Japan. This product has an oil absorbency of c. 95 g/100 g pigment, a mean particle size of about 4.6 to 5.1 μm as determined by means of a Malvern Mastersizer, and a B.E.T. surface area of about 320 $m^2 g^{-1}$.

Whilst an oil absorbency of about 80 g/100 g pigment represents an acceptable minimum threshold, higher oil absorbency pigments are preferred, for example pigments having an oil absorbency of at least 90 g/100 g.

The binder used is preferably a latex, typically a carboxylated styrene-butadiene copolymer latex such as that supplied as "DL 950" or "DL 930" by Dow Chemical. Other conventional paper coating binders can however be used, for example starch or polyvinyl alcohol, but these have so far been found to be less effective, perhaps because they "blind" the pigment in the coating, i.e. fill in the pores in the pigment surface and between adjacent pigment particles, so reducing the oil absorption capacity of the pigment coating. The greater oleophilicity of styrenebutadiene copolymers, compared with starch or polyvinyl alcohol, is also thought to be significant. Starch and polyvinyl alcohol also tend to have lower binding power than latex binders, and so are less effective in suppressing "dusting", i.e. detachment of the coated pigment particles from the paper during printing.

The dry ratio of pigment to binder should be at least 1:1 and preferably is greater than this, say 2:1, 3:1 or 4:1 (the minimum usable optimum ratios depend on the particular pigment and binder used).

The coating is preferably applied at a size press on the papermachine on which the paperboard is produced. The size press may be of the traditional kind, or may be of a modified design, for example a "Speedsizer" as supplied by Voith, a "Flexipress" as supplied by Jagenberg or a "Twin-HSM" as supplied by BTG. Alternatively other coating methods may be employed, provided they are suitable for the application of the desired low coatweights. Air knife coating is one such method. For economic reasons, on-line coating is preferred. If size-press coating is to be used, the mean particle size of the pigment desirably should be not more than about 5 μm.

The dry pick-up of the pigment/binder coating should be typically of the order of 1% to 4%, preferably 2% to 3%, based on the weight of the uncoated paperboard in the case of size-press coating, i.e. two-side coating, and correspondingly less in the case of single-side coating. Since the basis weight of the paperboards in question is typically 200-230 g m^{-2}, typical dry coatweights per side are therefore in the range 1 to 5 g m^{-2}.

The coating mix can contain dispersants and other conventional additives.

The final dried coated product can be calendered to the desired final smoothness and surface appearance and "feel" in the same manner as for conventional uncoated paperboard.

The invention will now be illustrated by the following Examples in which all parts, percentages and ratios, etc. are on a dry basis by weight unless otherwise stated:

Example 1

This illustrates the use of a low coatweight coating of an aluminosilicate pigment ("Zeocopy 133") and a binder on a 200 g m^{-2} woodfree paperboard as supplied by Arjo Wiggins Limited under the name "Hi-Speed Ivory Board". ("Hi-Speed" is a trade mark of Arjo Wiggins Limited). A variety of binder materials were used, as follows:

(i) carboxylated styrene-butadiene latex ("Dow DL950").

(ii) oxidised potato starch ("Perfectamyl P255SH", supplied by Tunnel Avebe)

(iii) a blend of starch and latex as just referred to in 1:2 weight ratio.

Compositions of 3:1 and 4:1 pigment:binder ratio were made up for each of binders (i) to (iii), the solids contents being of the order of 15-20% in each case.

The various compositions were each applied to a sample of paperboard by means of a laboratory size press at a range of pick-up values as specified below. After drying, the coated paperboards were each calendered to a Bendtsen smoothness value of the order of 80 to 100 ml min^{-1} and subjected to ink setting and print density testing as will now be described.

An IGT printability tester was used first to apply a known amount of ink to each paperboard sample and then to press the printed sample against respective reference paper samples at predetermined time intervals (1, 5, 10 and 20 min.). The reference paper was a pigment-coated paper of very high smoothness (1800 sec, Bekk) and low porosity (5 ml min^{-1}, Bendtsen). The density of the image transferred, i.e. set-off on to the reference paper, was then determined by means of a spectrophotometer (a reflectance of 0% indicates a completely black surface and a reflectance of 100% a completely white surface, i.e. the lower the reading, the worse the set-off). The ink used was a duct stable (i.e. very slow setting) ink supplied by BASF under the trade mark "Accolade".

The IGT printability tester was also used to print samples for print-density testing, measurements in this case being made by a Gretag Densitometer. This works on the reflectance principle so that the higher the reading obtained, the more intense the print.

Samples of uncoated paperboard were also subjected to the same test procedures to provide a control.

The results obtained are set out in Table 1 below, in which P and B denote pigment and binder respectively.

Table 1

Sample	Pick up %	SET-OFF INTENSITY AFTER:				Print Density
		1 min	5 mins	10 mins	20 mins	
CONTROL	-	61	68	77	78	1.8
P:B 3:1 (latex)	2	79	82	84	90	2.0
	3	86	89	94	96	2.1
	4	80	93	94	96	2.3
P:B 4:1 (latex)	1	80	87	90	93	2.0
	2	80	91	93	94	2.1
	3	85	92	95	96	2.2
P:B 3:1 (starch/latex blend)	1	65	77	80	82	2.0
	2	71	72	77	82	2.1
P:B 4:1 (starch/latex blend)	1	71	79	82	87	2.0
	2	76	84	87	94	2.1
P:B 3:1 (starch)	2.5	57	68	71	80	2.1
	3.5	68	74	86	88	2.2
P:B 4:1 (starch)	1.5	59	74	77	85	2.0
	3	62	75	78	88	2.1
	4	74	80	86	89	2.2

It will be seen that the presence of coatings in accordance with the invention produced significant decreas-

es in set off and/or increases in print density compared with the uncoated paperboard, provided that the binder and pigment:binder ratio were appropriately chosen. Starch was the least effective binder.

Example 2

This illustrates the use of certain of the coating compositions of Example 1 with a different type of ink, namely that supplied by BASF under the trade mark "Equinox". This is a roller stable ink which is slow setting, but not as slow setting as the ink used in Example 1. A composition with a 1:1 pigment:starch binder ratio was also evaluated.

The procedure employed was as described in Example 1, and the results obtained are set out in Table 2 below.

Table 2

Sample	Pick up %	SET-OFF INTENSITY AFTER:				Print Density
		1 min	5 mins	10 mins	20 mins	
CONTROL	-	67	82	87	91	1.8
P:B 4:1 (latex)	2.0	91	94	96	97	2.1
	3.5	97	99	99	100	2.2
P:B 3:1 (starch/latex blend)	2	75	88	89	97	2.0
P:B 3:1 (starch)	2.5	76	86	90	95	2.1
P:B 1:1 (starch)	3	74	86	89	95	1.9

It will be seen that all the pigment:binder coating compositions showed significant benefits compared with the uncoated paperboards, in terms of both improved set-off and improved print density, although the benefits with 4:1 pigment:binder ratio with latex as the binder were much greater than when starch was employed as the binder, either alone or in combination with latex.

Example 3

This illustrates the use of a high oil absorbency amorphous silica pigment ("Gasil 200 DF"). The binder used was a latex ("Dow DL 950"). The pigment:binder ratio was 4:1. The procedure was generally as described in previous Examples, with tests being carried out with the inks used in Examples 1 and 2 ("Ink 1" and "Ink 2" respectively).

The results obtained are set out in Table 3 below:

Table 3

Sample	Pick up %	SET-OFF INTENSITY AFTER:				Print Density
		1 min	5 mins	10 mins	20 mins	
CONTROL - Ink 1	-	61	68	77	78	1.8
CONTROL - Ink 2	-	67	82	87	91	1.8
Invention: Ink 1	2	89	89	92	97	2.2
	3	89	97	98	98	2.2
	4	90	98	100	100	2.3
Invention: Ink 2	2	97	98	100	100	2.2
	3	98	99	100	100	2.2

It will be seen that the use of the specified coating compositions gave significant benefits for both inks, compared with the uncoated paper, in terms of both set off and print density.

Example 4

This illustrates the application of the coating composition by means of a laboratory Meyer bar coater, rather than by the size-press application used in previous Examples. 4:1 pigment:binder ratio coatings utilising the same pigment and binder as in Example 1 were applied at two different coatweights, and the resulting coated products, together with an uncoated control, were tested for set-off (after one minute only) and print density as described in Example 1, except that the ink used was as in Example 2. The results obtained are set out in Table 4 below:

Table 4

Coatweight g m^{-2}	Set-off intensity after 1 minute	Print Density
- (Control)	67	1.8
3.5 g m^{-2}	100	2.2
5.0 g m^{-2}	100	2.2

It will be seen that the use of a coating according to the invention gave a marked improvement in set-off and print density.

Example 5

This illustrates the use of a range of different pigments of high oil absorbency, with low oil absorbency kaolin as a first control and two uncoated paperboards of 230 and 200 g m^{-2} grammage respectively as second and third controls. The procedure employed was generally as in Example 1, but with a pigment:latex binder ratio of 4:1 in each case. The pigments evaluated were as follows:

A. Aluminosilicate ("Zeocopy 133")
B. Aluminosilicate ("Zeolex 123")
C. Acid-washed montmorillonite ("Silton")
D. Calcinated clay ("Ansilex 93")
E. Kaolin ("SPS" supplied by English China Clays)

The results obtained are set out in Table 5 below.

Table 5

Pigment	Oil Absorbency (g/100 g)	SET-OFF INTENSITY AFTER:			Print Density
		1 min	5 mins	10 mins	
A	93	80	91	93	2.1
B	84	74	88	95	2.1
C	95	83	91	94	2.2
D	90	84	90	95	2.1
E (1st control)	40	69	82	84	2.1
None (2nd control)	-	61	67	77	1.8
None (3rd control)	-	62	68	75	1.9

It will be noted that the high oil absorbency pigments all gave better results than the low oil absorbency pigment, which itself gave better results than the uncoated products.

Example 6

This illustrates the use of the invention on paper board which had been conventionally internally-sized but had not been surface-sized or calendered prior to the application of the high oil absorbency pigment/binder composition. Thus it more closely approximates to use of the invention in routine production where the pigment/binder composition would normally be applied by means of a size press in place of a conventional surface sizing composition, and prior to final drying and calendering.

The procedure was generally as described in Example 1. The pigment and binder used were "Zeocopy" aluminosilicate and styrene-butadiene latex in 4:1 ratio. The ink used for testing was "Accolade" and the control was "Hi-Speed Ivory Board" both as referred to previously.

The results obtained are set out in Table 6 below.

Table 6

Sample	Pick up %	SET-OFF INTENSITY AFTER:			Print Density
		1 min	5 mins	10 mins	
CONTROL	-	61	67	77	2.0
Invention	3	86	90	93	2.1
	4	89	95	97	2.1
	5	94	98	100	2.1
	6	93	97	99	2.2
	8	95	99	100	2.2
	10	97	99	100	2.3

It will be seen that benefits were obtained with the invention at all pick up levels. The higher pick up levels (i.e. above 5%), did not give significant performance benefits compared with a 5% pick-up level.

Example 7

This Example illustrates the use of the invention on a fullsize paper machine equipped with a size press.

The paper machine was used to produce a conventional c.250 g m $^{-2}$ paperboard of the general kind described in Example 1, with the size press being used to apply a low dry coatweight aqueous coating composition comprising an aluminosilicate pigment ("Zeocopy 131") and a styrene-butadiene latex binder ("Dow Latex 930"). The pigment:binder ratio was 4:1, and the solids content of the composition was 15%. Samples of the resulting product were taken at the start, middle and end of the production run. Both surfaces of each sample were tested as described in Example 1 using "Accolade" ink, but with additional set-off measurements after 30 and 45 minutes. Measurements were also made on control paperboard made in the same production run but without the use of the size press, i.e. with no coating being applied.

The results obtained were as set out in Table 7 below.

Table 7

Sample		Pick up %	SET-OFF INTENSITY AFTER: 1 min	5 mins	10 mins	20 mins	30 mins	45 mins	Print Density
Start	T	2.0	65	81	87	95	96	98	1.9
	B		51	70	87	87	92	93	1.9
Middle	T	2.8	65	76	86	92	97	97	2.0
	B		56	68	75	91	90	96	2.0
End	T	2.8	77	88	92	96	97	97	2.0
	B		71	81	86	92	95	96	1.9
Control	T	-	73	81	83	85	87	88	1.8
	B		73	81	84	85	87	88	1.8

Key: T = Top Surface B = Bottom Surface

The difference in set-off intensity values between the two surfaces of each of the coated samples is thought to be a result of the pick-up being greater on the top surface than on the bottom surface.

It will be seen that the presence of the coating gave enhanced set-off performance and a small improvement in print density.

Example 8

This compares the performance of a high oil-absorbency aluminosilicate pigment ("Zeocopy 131") with that of two low oil absorbency paper coating pigments as controls, namely a calcium carbonate pigment of oil absobency c. 17 g/100 g pigment ("Hydrocarb" ground calcite, supplied by Croxton & Garry, Redhill, UK) and a kaolin pigment of oil absorbency c. 45 g/100 g pigment ("Supreme", supplied by English China Clays). The binder used was a fully hydrolysed medium viscosity polyvinyl alcohol, with a 4:1 pigment:binder ratio in each case. However, this was found to give insufficient binding in the case of the aluminosilicate pigment, with the result that no print density value could be obtained, and so the work was repeated for this pigment with a 2:1 pigment:binder ratio. The experimental and testing procedures were generally as described in Example 1 except that the paperboard product tested was an unsized "Bristol" board of c. 200 g m $^{-2}$ grammage. A control sample was also prepared using a starch sizing composition containing no pigment. The results obtained are set out in Table 8 below.

Table 8

Sample	Pick up %	SET-OFF INTENSITY AFTER:				Print Density
		1 min	5 mins	10 mins	20 mins	
Aluminosilicate (4:1)	2.5	88	95	97	98	-
Aluminosilicate (2:1)	2.5	84	87	92	94	2.1
Control (Calcite)	2.5	72	82	88	93	1.9
Control (kaolin)	2.5	79	88	91	95	2.0
Control (starch only)	2.5	75	83	87	91	1.8

It will be seen that all the aluminosilicate coating compositions showed significant benefits compared with the control samples in terms of both improved set-off and improved print density.

Claims

1. An improved printability paperboard of the kind used for making business cards, invitation cards, menu cards, report covers and the like, characterized in that the paperboard carries a low coatweight coating of (a) a pigment having an oil absorbency of at least about 80 g/100 g pigment, and (b) a binder.

2. An improved printability paperboard as claimed in claim 1, wherein the high oil absorbency pigment has an oil absorbency of at least 90 g/100 g pigment.

3. An improved printability paperboard as claimed in any preceding claim wherein the high oil absorbency pigment is an aluminosilicate, a synthetic amorphous silica, a calcined kaolin, or an acidwashed montmorillonite clay.

4. An improved printability paperboard as claimed in any preceding claim wherein the binder is a styrene-butadiene latex.

5. An improved printability paperboard as claimed in any preceding claim wherein the dry ratio of high oil absorbency pigment to binder is at least 2:1, preferably at least 3:1.

6. An improved printability paperboard as claimed in any preceding claim wherein the coatweight of the coating is from 1 to 5 g m^{-2}.

7. An improved printability paperboard as claimed in any preceding claim wherein the paperboard has a grammage of at least 180 g m^{-2}, preferably 200 to 400 g m^{-2}.

8. An improved printability paperboard as claimed in any preceding claim, wherein the paperboard has a thickness of at least 150 μm, preferably 250 μm to 380 μm.

9. An improved printability paperboard as claimed in any preceding claim, wherein the paperboard is woodfree in nature.

10. The use, for the purpose of improving the printability of paperboard of the kind used for making business cards, invitation cards, menu cards, report covers and the like, of a low coatweight coating of (a) a pigment having an oil absorbency of at least about 80 g/100 g pigment, and (b) a binder.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 7214

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	DATABASE WPI,n 89-239053,Derwent Publications ltd,London,GB; & JP-A-1174697(JUJO PAPER) *The entire abstract* ---	1-4	D21H19/40 D21H19/58
X	DATABASE WPI,n 93-331912,Derwent Publications Ltd,London,GB; & JP-A-5239799(OJI PAPER) *the entire abstract* -----	1-4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			D21H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 January 1995	Fouquier, J-P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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